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Pelvioprostatic Venography and Method of Estimating Size of Prostate Gland

By

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Total exstirpation of the organs is commonly performed today upon the malignant tumors of bladder and prostate. It is very important to know the grades of its invasion to their adjascent tissues for adequate performances.

In discussing this problem, some authors such as De la Pana[1], Ceccarelli[2], Abeshouse & Ruben[3], Fitzpatrick and Orr[4] and some others have tried a procedure roentgenologically to demonstrate the pelvic veins, injecting opaque media into the v. dorsalis penis profunda.

These studies have dealt, however, only with some cases of hypertrophy or malignant tumors of prostate and indicate lack of systematical examinations. The present writers undertook to get some patterns of this venography, and carried through this procedure on fifty-one cases with such prostate as normal and insane, coming to some conclusions. The aim of this report is to describe their new observations about cancer and other pathological conditions of the prostate.

Technique

Patients are positioned on the roentgen table with the grid of Potter-Bucky. A slight incision is made on the dorsal surface of penis, and the needle is inserted into the exposed vena dorsalis penis profunda, then 15 to 30 cc of 35 per cent Sugiuron or 70 per cent Pyraceton is rapidly injected. During the injection of the last 3 cc antero-posterior exposures are made. Center is in the mid-line, at the level of the anterior-superior iliac spine, exposure factors are 60 KV peak, 40 milliamp., 3″, 91 cm.

In something over half of all cases cystographies were made at the same time with 100 to 150 cc air inflation or injection of 20 cc of 10 per cent sodium jodati solution, and in some cases Takahashi-Okoshi's method of cystography was also employed simultaneously. After the exposure the incision is closed with two or three silk sutures.

Interpretation of the Findings

By the technique above described pelvioprostatic venography was performed of 17 cases with normal prostate, 7 with prostatic cancer, 2 with prostatic calculi, 8 with tuberculous and nontuberculous prostatitis, 3 cases of bladder tumors (cancer 1, papillom 2), and 2 other miscellaneous cases, 51 cases in all. The conclusive findings from them, disregarding some doubtful matters, are as follows:

1) In cases with *normal prostates*, the venograms are as shown in Figs. 1, 2, & 3. The opaque media injected into the v. dorsalis penis produnda comes together into the plexus pudendalis which is situated at the lower part of the pubic arch, then leaves in two ways, streaming above into the plexus vesicalis and below into the v. pudenda interna; the latter two unite together in the v. hypogastrica, communicating commonly with v. iliaca communis, and rarely with v. iliaca externa. Halfway within these

1) De la Pena, A.: Z. f. Urol. **44**, 516 (1951).
2) Ceccarelli, G.: Urologica **17**, 377 (1950).
3) Abeshouse, B. S. & Ruben, M. E.: J. Urol. **68**, 640 (1952).
4) Fitzpatrick, R. J. & Orr, M.: J. Urol., **68**, 640 (1952).

courses, v. pudenda interna communicates with v. obturatoria, plexus vesicalis with v. hemorrhoidalis. Venae ileolumbales and v. glutae are at times to be discerned. These venographic patterns are symmetrical in both sides; the venous passages can be recognized more strikingly when films are viewed in stereo.

Plexus pudendalis is a round, oval or irregular network of veins and plexus vesicalis also consisted of several strips of veins but the latter takes the form of a single vein before emptying into the v. hypogastrica.

The angle which is made by the veins of the plexus vesicalis of the two sides is in general less than 90°, 70° is most common (Fig. 4), but in some exceptional cases, the angles are wider, coming up to 100° or more (Fig. 5) (Table 1). Yet there are some variations in the case of normal prostate, viz., the smallness of plexus pudendalis because of to its scanty vascularity (3 cases) (Fig. 6), or entire absence of venogram of one side (frequently seen in the left, 2 cases) (Fig. 7). If the opaque madia is injected erroneously into the superficial dorsal vein of penis, pelvioprostatic venogram connot be taken but the dye will demonstrate v. pudenda externa and communicating v. femoralis (Fig. 19).

2) In cases of *prostatic cancer* in comparison with cases of normal prostate, plexus pudendalis is scantier of vessels and smaller in size; its connecting plexus vesicalis shows fewer branches, is irregular in its distribution and commonly thin.

When the tumor is small, the changes above described are very slight and it is difficult to find out the differences from the normal. But when the tumor is extremely great, plexus vesicalis on one or both sides (rarely plexus pudendalis too), can not be delineated, but direct anastomosis of the deep dorsal vein of penis to internal pudendal vein would be observed, as a result of tumor expansion and invasion to the surrounding tissues. The relative paucity of vessels, the lack of distention and areas of irregular filling are very striking in the cases of carcinoma of prostate (Figs. 8–12). These findings have also been observed by Ceccarelli and Abeshouse-Ruben. Abeshouse-Ruben thought this phenomenon to be attributable to the thrombosis of veins and very suggestive of malignancy. Among our seven tumor cases, the lack of vesical plexus was seen in both sides (1 case) (Fig. 11), in one side (3 cases) (Figs. 12, 8). In the case which showed the lack of plexus vesicalis of both sides, plexus pudendalis was also lacking and direct anastomosis of deep dorsal vein of penis to inner pudendal vein was seen (Fig. 11). The angle made by veins of plexus vesicalis of both sides was very great, that is within 100–150°.

3) *Prostatic hypertrophy.* Vascularity of both pudendal and vesical plexuses are more scanty and more slender than normal (Figs. 13, 14). But the irregularity of vascularisation of plexus vesicalis as shown in cases of prostatic cancer, the so-called "thrombosis of veins" of Abeshouse-Ruben, was rarely observed and also complete absence of this plexus was seen in only a few cases. This is probably because of the lack of infiltration into the neighbouring tissues as seen in the cases of cancer. In our experiences, only one case out of ten did not demonstrate the vesical plexus and it was in one side only.

The angles made by the veins plexus of both sides were more wide than normal in the cases of prostatic hypertrophy as in the cases of the cancer, but narrower than in the cases of true cancer, viz., they were between 90° and 100°, 90° in seven cases, 100° in 3, ten cases in all.

4) *Prostatic abscess.* In two cases of this disease, where prostate glands attained the size of goose-eggs, the pudendal plexus got smaller and the vesicalis were narrow and partially deficient in their vessels, but thrombosis of the veins as in prostatic cancer was not recognized in them (Fig. 15). The angle of vesical plexus was as a matter of course wide, ranging 100–130°.

5) *Prostatic calculi.* Almost similar findings as in prostatic hypertrophy were made; it was definitely observed that the shadow of the calculi lay between the vesical plexus of the two sides and surrounding the shadow of the calculi ran the vessels of the vesical plexus (Fig. 16).

6) *Prostatitis* of tuberculosis or of other nature. Quite the same conditions were found in these cases as in the normal. Nothing characteristic was seen.

7) *Vesical neoplasmas.* In a case of vesical papilloma with prostatic hypertrophy, defect of the shadow of left vesical plexus was demon-

strated; other cases of this disease have no characteristic venogram even in a case of cancer situated over the most part of the bladder wall and infiltrating into all its layers (Fig. 17).

8) *Other miscellaneous diseases.* (i) In a case of seminoma which resulted in anuria because of its retroperitoneal lymphatic metastases (Fig. 18), it was demonstrated that a round or oval dense networks of shadows were multiplied in the minor pelvis. This may be attributable to the new vascularization round the metastatic lymphnodes. (ii) A case of penile cancer with the metastases to the inguinal and femoral lymphatic nodes. In this case the pelvioprostatic venogram did not belong to any particular pattern, but the injection of opaque media into the subcutaneous dorsal vein of penis revealed multiple branched fine network of veins in the left femoral part which have gotten edema because of metastases (Fig. 19). (iii) A case of Recklinghausen's disease with partial defect of pubic bone; the venography demonstrated asymmetrical vesical plexus and internal pudendal veins of both sides (Fig. 20).

There were side reactions to this procedure: general heat feeling, metallic taste, and dumb pain in the pelvis at the time of dye injection were seen in almost all cases. Rarely nausea (2 cases), or slight urticaria (5 cases), were also experienced, but they were transient. No postoperative distress caused by incision was seen in any case.

Another Application of this Venography

In connection with recent progress in the methods of surgical operation and antiandrogenic therapy for cancer and hypertrophy of the prostate, measurement of its size especially of enlarged one is one of the important things in determining the method of prostatectomy, in making prognosis and in following up the amelioration by treatment. It is now, therefore, widely attempted to estimate the size of the prostate gland roentgenologically. The bag-catheter method of Peirson and Wilson (1941)[5], the cystographic method of Ichikawa-Okoshi-Kuroda (1952)[6], the cystourethrogram method of Thumann (1951)[7] and of Boone (1952)[8] these are examples. Except for the relatively perfect method of Ichikawa-Okoshi-Kuroda, every method above-mentioned has its own deficiency in fulfilling our need.

The writers, therefore, adopted the above described pelvioprostatic venography in order to estimate the size and weight of prostate as accurately as possible. The prostatic vertical diameter is anatomically the distance from the upper rim of pudendal venous plexus to the base of the bladder, and when the prostate is neoplastic, the distance to its most projected point into the bladder. Venographically by our method, in combination with pneumocystography or with its variation of Takahashi-Okoshi, it is therefore reasonable for one to take the diameter of the prostate to be the distance from the transition point of vesical and pudendal plexus to the bladder base or to the apex of the prostatic projection into the bladder (Fig. 21). Measurements have been made of this distance by the combination radiography, just mentioned, in various cases, comparing with that of Ichikawa-Okoshi-Kuroda's method published by Kuroda.

In the obtained results, as shown in Table 2, the vertical diameters of normal prostates were less than 3 cm (the greatest 3.0 cm, the smallest 1.5 cm, average 2.33 ± 0.0428 cm), in accord with Kuroda's results obtained by his method above mentioned, especially those of anteroposterior position (Table 3); in neoplastic cases, all were more than 3.0 and less than 6.0 cm, excepting two cancer cases of which the diameters were 2.6 cm; in the 8 cases of prostatic calculi and prostatitis, they were less than 4.0 cm.

In one case each of cancer and hypertrophy of prostate gland, a comparison was made of roentgenologic estimation and the actual size of enucleated tumors; the results were in good accordance (Table 4).

Thumann has devised a formula ($R^3 \times 2 = W$) for estimating roentgenologically the weight of the hyperplastic prostate by means of measure-

5) Peirson, E. L. & Wilson, S. A.: J. Urol. **45**, 82 (1941).
6) Kuroda, Kyoichi: Jap. J. Urol. **43**, 83 (1952).
7) Thumann, R. C.: Am. J. Roentgenol. **65**, 593 (1951).
8) Boone, R. W.: J. Urol. **67**, 358 (1952).

ments of horizontal and vertical diameters. In this case, the vertical diameter means the distance from the imprint of verumontanum on an anteroposterior cysto-urethrogram to the most superior extent of the prostatic mass as seen on it; when the imprint of the verumontanum cannot be discerned accurately, then the external sphincter is used as the distal extent, substracting from the vertical diameter 1.5 centimeters, which is the average distance from the upper end of the external sphincter to the upper end of the verumontanum. The horizontal diameter is found by measuring the distance between each lateral margin of the prostatic mass at its widest part. In this formula, R is the radius in centimeters calculated from the average diameter of the horizontal and vertical measurements, regarding the hyperplastic prostate as a sphere, oval or round; W is the weight in grams of the prostatic adenoma.

The writers applied this formula on their venogram. The vertical diameter in the present method is, as described above, somewhat different from Thumann's. The horizontal is the same as taken by him. The theoretical was compared with the actual weight of enucleated prostate in one case of cancer and three cases of hypertrophy; it was found that they bore a close resemblance to each other, and that the differences between them was only 1–1.5 g as shown in Table 4, and smaller than the results obtained by Thumann's cysto-urethrographic estimations.

It is a pleasure to record here a debt of gratitude to Professor S. Watanabe for his kind instructions and to the memberes of the Department of Radiology for technical asistance.

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Conclusions

The method of a pelvioprostatic venography and the patterns in normal and various prostatic diseases were described.

This venography is suggested as an auxiliary diagnostic method in the differentiation of intrapelvic neoplasmas and is useful for the measurement of the size and weight of the prostate gland.

Other Literature

1) Baston, O. V.: Ann. Int. Med., **16**, 38 (1942).
2) Beneventi, F. R. & Norback, G. J.: J. Urol., **62**, 663 (1949).
3) Gray, J. H.: Anatomy of the Human Body. 25 th Ed. (Phila. 1948).

Table 1 *Angles Made by the Veins of Vesical Plexus of Both Sides in Various Prostatic Diseases*

Diagnosis	No. of cases	Angles														
		55	60	65	70	75	80	85	90	95	100	110	120	140	150	Undetermined++
Cancer	7									1	(1)	(1)	(1)		1	1
Hypertrophy	10								7		2(1)					
Abscess	2										(1)			1		
Calculus	2					1			1							
Prostatitis+	7		1		1		2		3							
Normal	17	1			6	2	2	2	4							
	45															

\+ Including tuberculosis
Bracket ( ) means the case which showed the defect of the plexus in one side. The angle was calculated on the assumption that it existed symmetrically in the opposite side.
++ Undetermined means cases which showed the defect on both sides.

Table 2 *Venographic Measurements of the Vertical Diameter of the Prostate in its Various Diseases*

Diagnosis	No. of cases	Diameter cm.					
		1.1–2.0	2.1–3.0	3.1–4.0	4.1–5.0	5.1–6.0	More than 6.1
Cancer	4		2		2		
Hypertrophy	7			3	3	1	
Abscess	2				1	1	
Calculi	1			1			
Prostatits+	7	3	2	2			
Normal	16	2	14				
	37						

+ Including tuberculosis of the prostate

Table 3 *Comparison of Various Roentgenologic Measurements of Virtical diameter of the Normal Prostate Glands*

Methods and Authors		No. of cases	Vertical diameter cm.		
			shortest	longest	Average
Peirson-Wilson (1941)		14			3.1
Kuroda (1952)	Actual length	31	1.7	2.9	2.30±0.0625
	Rectal method	34	1.7	2.8	2.24±0.067
	Urethral method	31	1.7	2.9	2.26±0.0609
	Antero-posterior method	31	1.7	2.9	2.36±0.0182
	Oblique method	31	2.0	3.0	2.47±0.054
Tozuka-Kuroda-Torimoto (present paper) (1953)		16	1.5	3.0	2.33±0.054

Table 4 *Comparison of the Theoretical Values Calculated from our Venography with the Actual Size and Weight of the Enucleated Prostates*

Cases			Vertical diameter cm.	Horizontal diameter cm.	Weight gr.	Remarks
1	Prostatic cancer 68 ys.	Theoretical	2.5	5.5	16	Total prostatectomy
		Actual	2.3	5.0	17	
2	Prostatic hypertrophy 63 ys.	Theoretical	4.9	5.5	34	Retropubic prostatectomy
		Actual	4.3	5.1	32	
3	Prostatic hypertrophy 69 ys.	Theoretical	3.5	6.0	25.5	ditto
		Actual			24	
4	Prostatic hypertrophy 73 ys.	Theoretical	4.6	3.7	17.5	ditto
		Actual			14	

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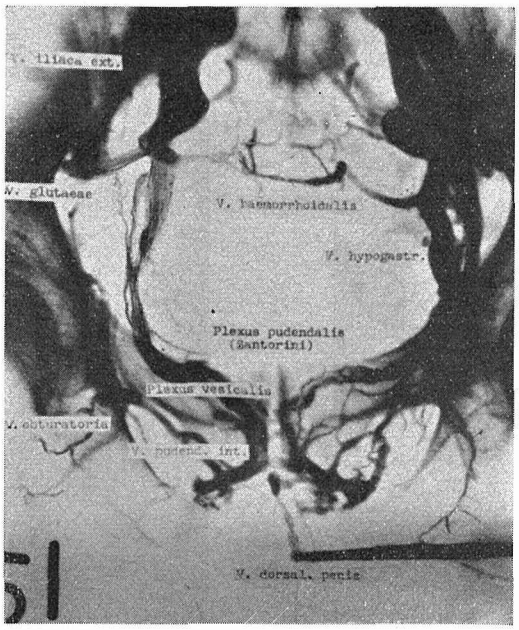

Fig. 1 Normal Prostate.

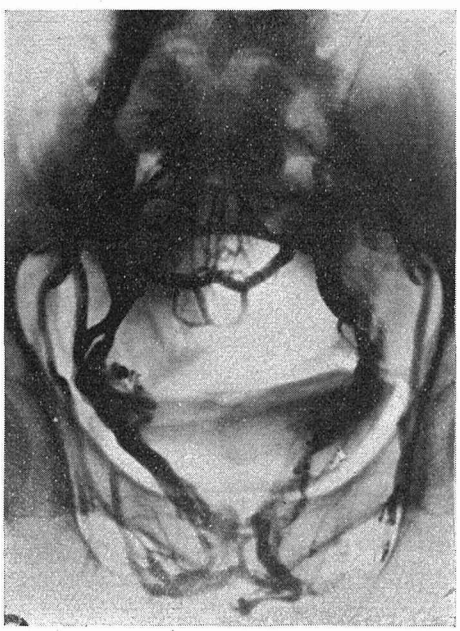

Fig. 2 Normal prostate.

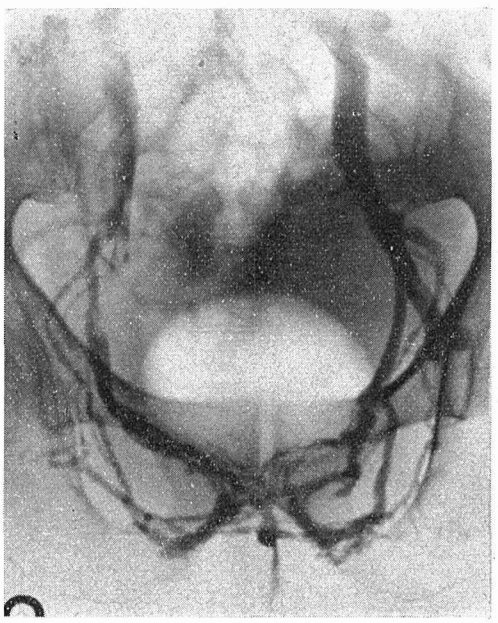

Fig. 3 Normal prostate.

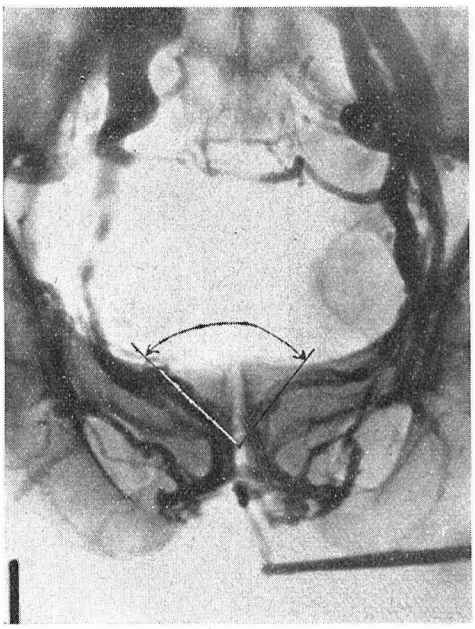

Fig. 4 Normal prostate. The same case as Fig. 1. The two straight lines on the plate show the angle made by the veins of the plexus vesicalis.

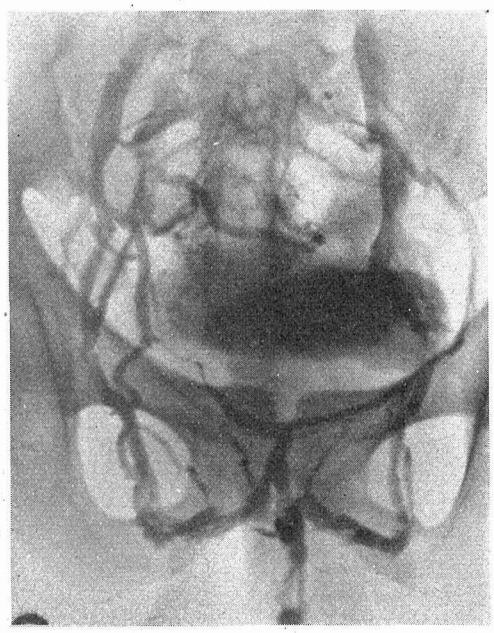

Fig. 5 Normal prostate, but the angle of plexus vesicalis is exceptionally great.

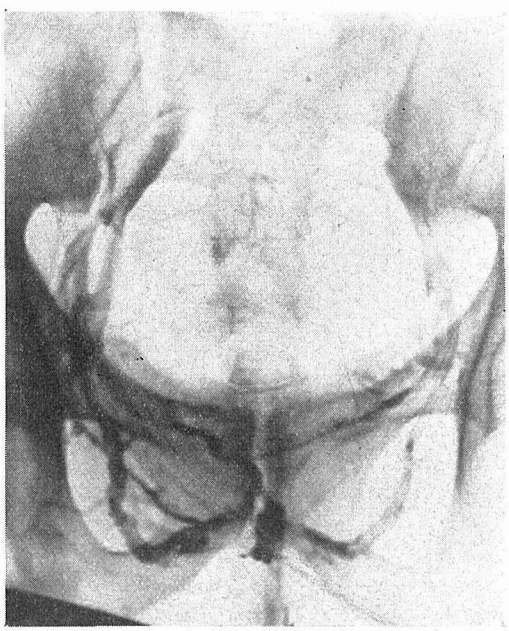

Fig. 6 Prostate normal, but the venogram reveals the smallness of plexus pudendalis because of its scanty vascularity.

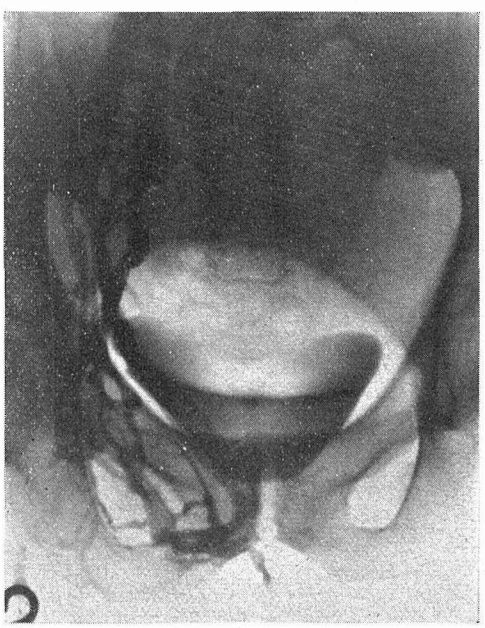

Fig. 7 Normal prostate, showing complete absence of venogram of left side.

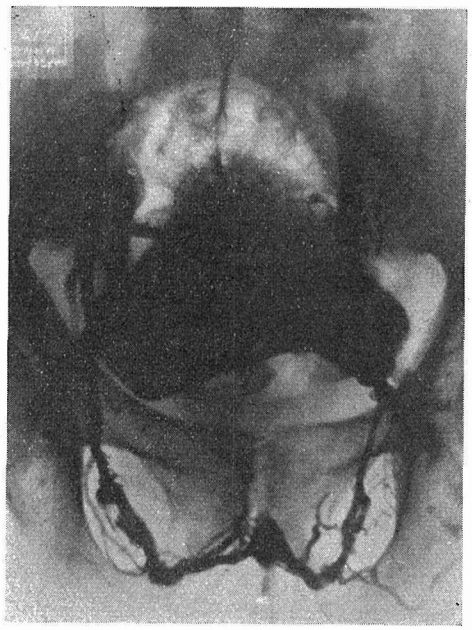

Fig. 8 Prostatic cancer. Lack of vesical plexus of left side is shown.

Fig. 9 Prostatic cancer.

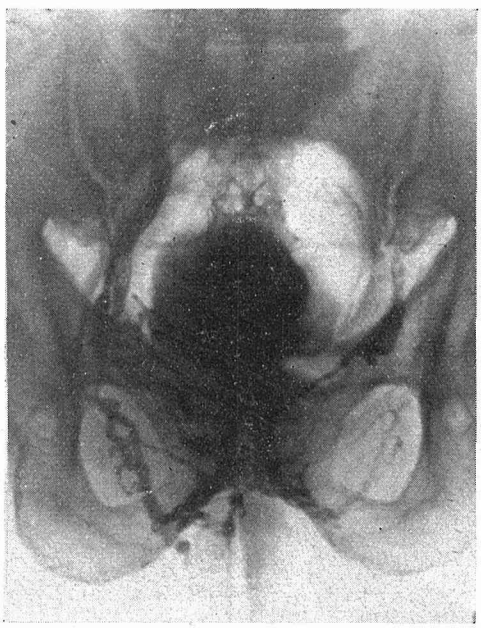

Fig. 10 Prostatic cancer.

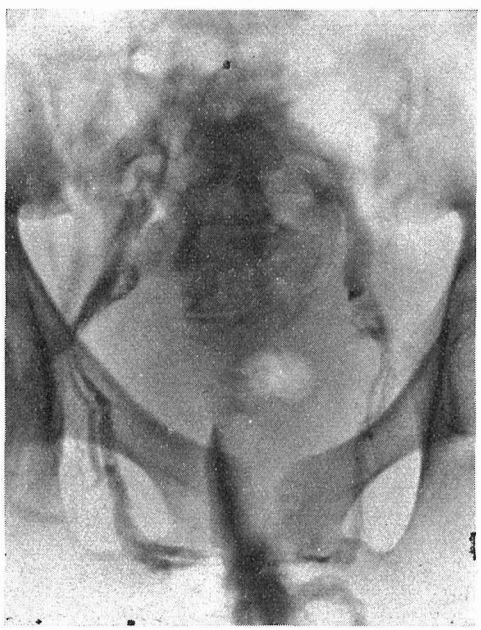

Fig. 11 Prostatic cancer, venogram reveals lack of vesical plexus of both sides.

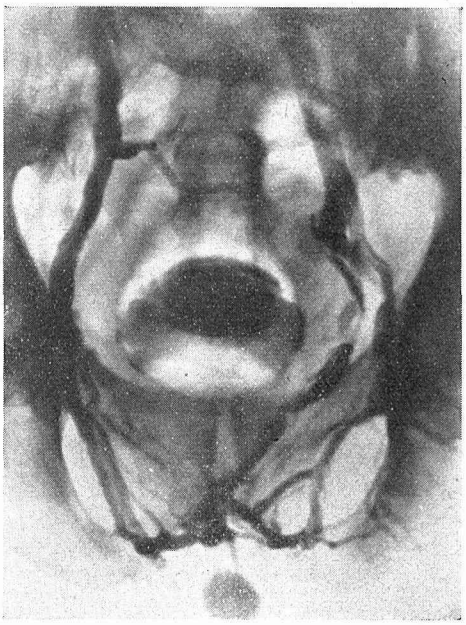

Fig. 12 Prostatic cance. The right vesical plexus is not delineated.

Fig. 13 Prostatic hypertrophy.

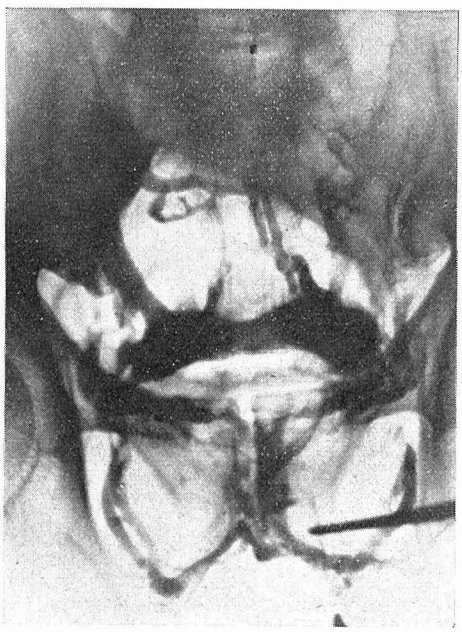

Fig. 14 Prostatic hypertrophy.

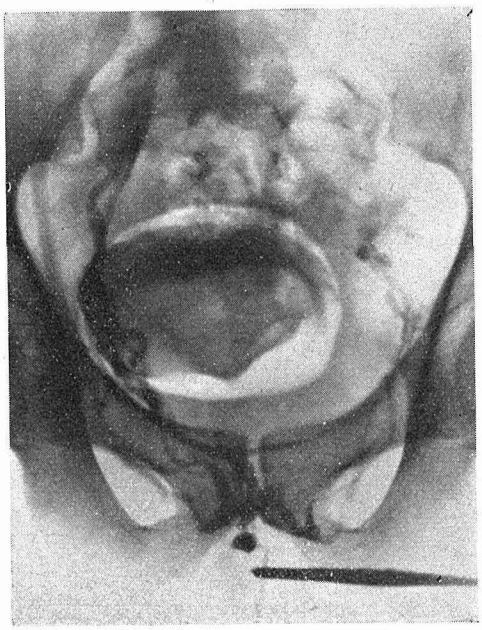

Fig. 15 Prostatic abscess.

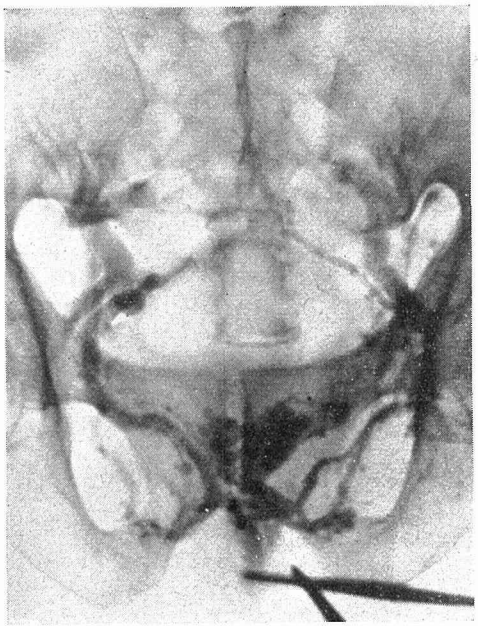

Fig. 16 Prostatic calculi.

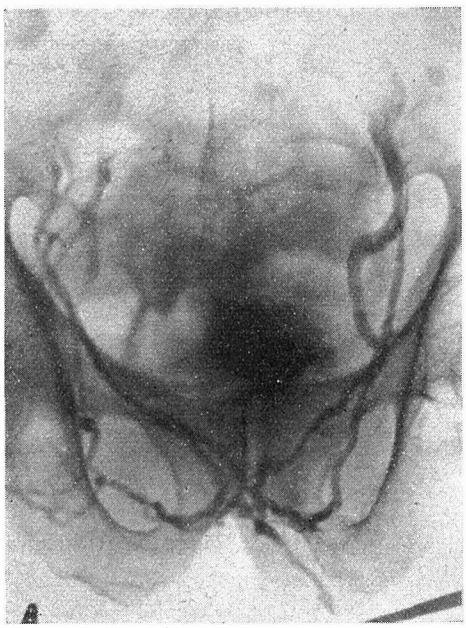

Fig. 17 Carcinoma of the urinary bladder infiltrating most of the vesical wall but with normal prostate.

Fig. 18 Seminoma of the testis with retroperitoneal lymphatic metastases.

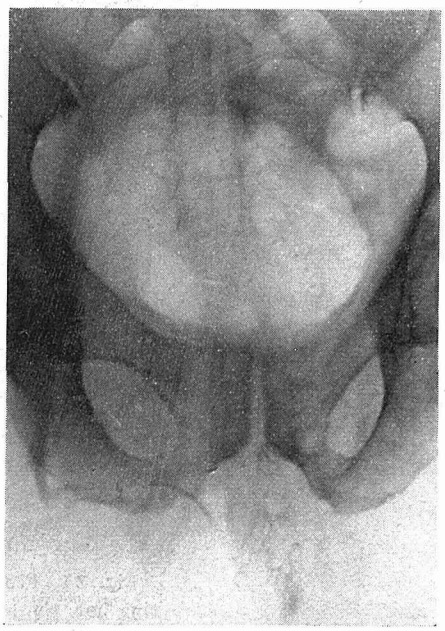

Fig. 19 Penile cancer. Opaque media was injected into the subcutaneous dorsal vein of penis.

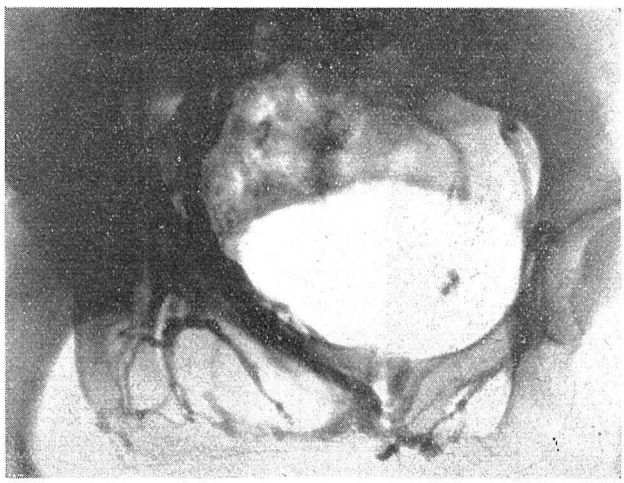

Fig. 20 Recklinghausen's disease with partial defect of pubic bone.

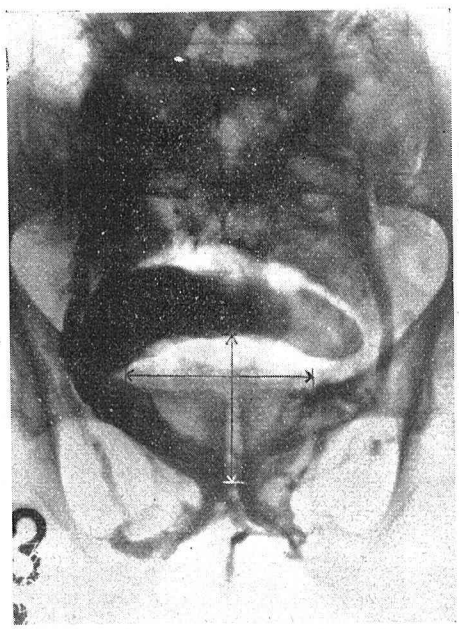

Fig. 21 Prostatic hypertrophy. Demonstrating how the measurements may be made of the vertical and horizontal diameters.